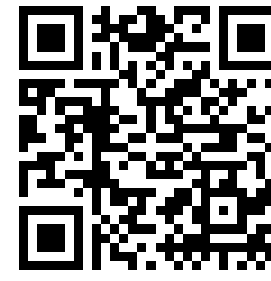


SURVEYING OUR PUBLIC LANDS

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
1980

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources.

Interior, America's "Department of Natural Resources," works to assure the wisest choice in managing all of our resources so that each will make its full contribution to a better United States - now and in the future.

Human resources, too, are fully acknowledged to be Interior's responsibility. The Department pledges a responsible concern for human values, and to provide an equality of opportunity for all as it works to manage a balanced use of our Nation's natural resources.

The Bureau of Land Management is part of the United States Department of the Interior. Its responsibilities encompass 450 million acres of public lands, an area more than 10 times the size of New England. Approximately 175 million acres are located in 12 Western States, and 285 million acres are in the State of Alaska. BLM, as the Bureau is generally known, is also responsible for mineral leasing on submerged lands of the Outer Continental Shelf and on many lands managed by other agencies.

Established on July 16, 1946, by the consolidation of the General Land Office (created in 1812) and the Grazing Service (created in 1934), much of the history of the exploration and development of the Public land states appears on the pages of the Bureau's records. As manager of more than half of all Federally owned lands, BLM's primary purpose is the wise administration, selective disposition, conservation, and management of national lands and resources for balanced use. These resources, besides the land itself, include minerals (oil and gas), forests, range vegetation, recreation, wildlife, and soil and water. To manage these resources, the Bureau must be able to accurately identify and locate the increasingly valuable areas of land with which it has been entrusted.

Federal Cadastral Surveys create, restore, mark and define the boundaries of these lands.

Surveying Our Public Lands . . . .

History . . . .

Land surveying dates back to ancient times. More than one civilization recognized the need for marking the boundaries of land for taxing purposes as well as for defining just where one ownership begins and another ends.

The Egyptians, with their great expertise and accuracy in building pyramids more than 7,000 years ago, must have possessed the techniques and instruments to perform surveys which are comparable in precision to some present day requirements. In fact, the Egyptians were very much involved in property surveys since land boundaries along the Nile River were annually lost from flooding, and resurveys were constantly needed.

Most modern BLM monuments have an inscription which reads "UNLAWFUL TO DISTURB." Such warnings are really not at all new. Babylonian boundary stones set about 3500 years ago contain not only geographical information and the surveyor's name, but also numerous curses on anyone daring enough to move the monument!

There were several other notable surveying endeavors in earlier times including the Roman rectangular plots which were laid out with the four-armed groma instrument, William the Conqueror's land surveys of England with their resultant "Domesday Book," and the pyramid, road, city and bridge related surveys of the 11th to 14th century Incas.

In early day America, several types of surveys were performed, utilizing state-of-the-art instruments, and calling principally on mathematicians, astronomers, and navigators to perform as land surveyors. Most of these earlier surveys were of the metes and bounds type, meaning they were established by distances and directions which were not in accordance with a regular pattern. Some prominent surveyor names from that time include Roger Sherman, Charles Mason and Jeremiah Dixon, David and Benjamin Rittenhouse, Thomas Jefferson, and George Washington.

But, it remained for the late 1700's of colonial America for the beginning of what was to become the most ambitious program of land disposal, ownership recording, and actual on-the-ground boundary marking which has ever occurred. Described as a "marvel of simplicity," the United States rectangular survey system was designed to layout one mile square parcels over all of the Federal lands outside of the original thirteen colonies and their western territories.

A contemplation of the scope of establishing such a minute, legally acceptable, and accurate grid system across a billion and a half acres of the thirty "public land states" is truly an appreciation of the magnitude of effort involved in "Surveying Our Public Lands."

Actual authority for starting the United States rectangular survey system occurred on May 20, 1785, when the Continental Congress approved modified recommendations of a committee chaired by Thomas Jefferson. Actually, the committee's work was the culmination of much thought, debate, and evolvement of earlier survey activities. Two military engineers, Colonel Henry Bouquet and Thomas Hutchins were among the original major contributors. (Hutchins later became the first geographer of the United States). In any case, the 1785 Land Ordinance laid the legal and technical foundation for the country's public land surveys of almost the past two hundred years.

With Hutchins' personal attention, the first surveys under the ordinance took place in Ohio where the west boundary of Pennsylvania crossed the north boundary of the Ohio River. The first township was surveyed by Absolom Martin of New Jersey in 1786. The State of Ohio was the testing ground for the new type of surveys, and some changes were made in the law as a result of experience gained in the surveys in that State.

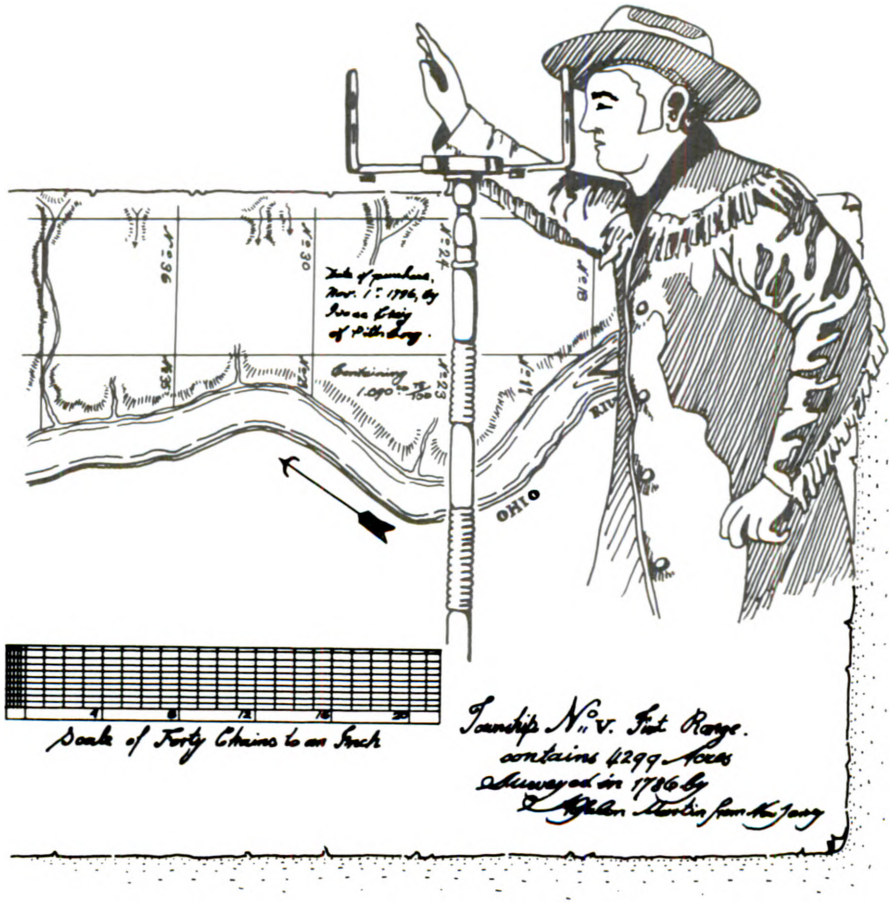
By 1805, the rectangular surveys were started across Indiana. The system's elements had been well settled by then, and the surveys were eventually extended westward to the Pacific Ocean.

The plan developed three new theories in land administration. First, the principle of "survey before settlement"; second, the principle of a mathematically designed plan to be followed throughout the entire area of the public domain; and third, the creation of a standard land unit, the section, of uniform shape and area and with boundaries physically marked on the ground. These features did not follow any plan in use within the area of the original Colonies in America, where land locations were made in irregular form and without any orderly plan.

In 1812, the General Land Office was established by Congress as a bureau of the Treasury Department "to superintend, execute, and perform all such acts . . . respecting the public lands . . .". Before then, the public domain workload was handled by the Treasury Department, but it was recognized that a more focused land management agency was needed. However, the Surveyor General posts, with responsibility for contracting surveys to private surveyors, remained independent of the GLO.

Edward Tiffin of Ohio was appointed the first commissioner of the GLO. Tiffin's contributions to land surveying were significant in consolidating and organizing land and survey records, and later as a Surveyor General, in designing a plan of correction lines for the solution of the troublesome problem of conforming a rectangular pattern to a round earth.

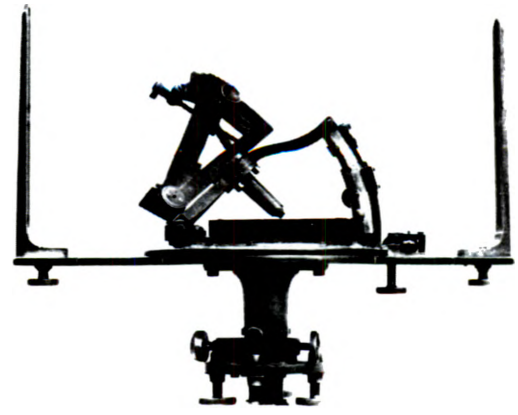
Another remarkable pioneer surveyor was William Burt who surveyed large areas of land in upper Michigan and Wisconsin in the mid 1800's. Burt, who did not have much of a formal education, was the inventor of the solar compass which used the sun to maintain direction, instead of the magnetic compass. His invention came



of necessity from trying to run lines in a region of vast iron deposits which caused deviations of the compass needle.

The exploration and survey of the western lands continued with many verbal and written accounts by curious surveyors of colorful discoveries of the nature of a new land, and tales of hardship, misery, and financial loss. One 1852 field note record of an Iowa survey reads ". . . one of my men was accidentally shot yesterday and died almost instantly." The notes continue with bearings and distances to the stricken Ivy Johnson's grave.

Burt Solar Compass



Until 1910, the public land surveys were generally administered by regional Surveyors General who

contracted with authorized Deputy Surveyors to perform the work. Sets of instructions to the Deputies were often written by the Surveyor General to specify the method of survey, and the accuracies expected. However, it gradually became evident that a consolidation of officially authorized surveying procedures was needed. An Oregon Manual of Surveying Instructions was published in 1851, and a revision of this Manual was published by GLO in 1855 for national use. Subsequent manuals were issued in 1871, 1881, 1890, 1894, 1902, 1930, 1947 (BLM), and 1973 (BLM).

In the land surveying profession, integrity is recognized as one of the most desirable attributes for surveyors. Although the contract system of conducting government surveys had been mostly successful for more than one hundred years; it was proposed that better control over the soundness of individual projects, and greater public responsiveness could be obtained by appointing a corps of directly employed government surveyors. Starting from July 1, 1910 until the present, most Federal Cadastral Surveys have been performed by Federally employed surveyors.

Growth of the public domain . . . .

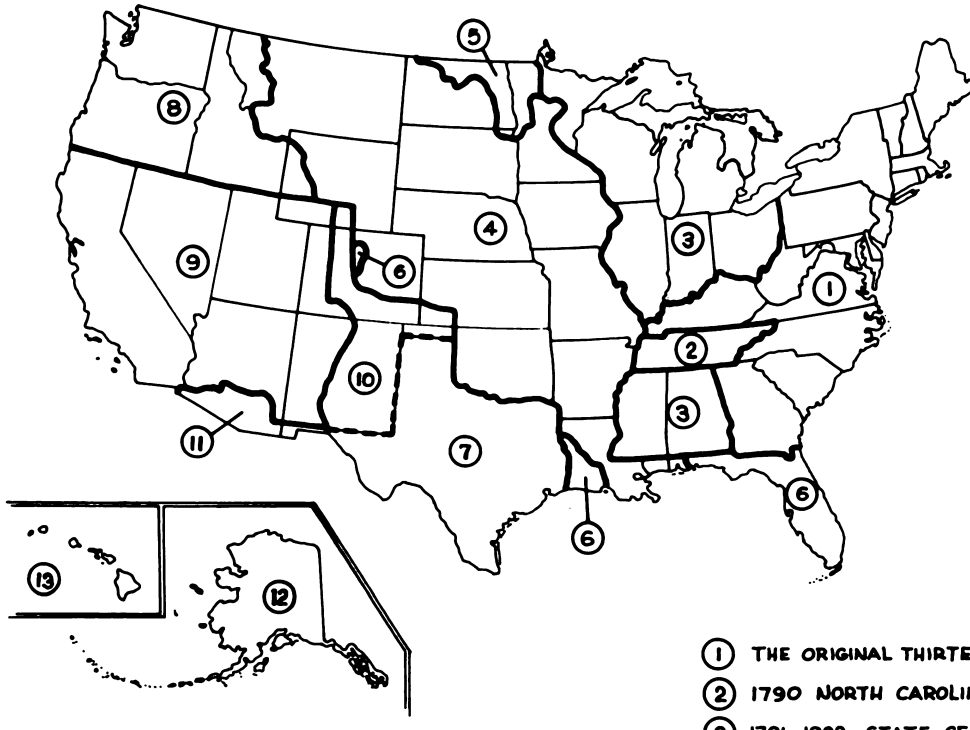
In 1803 President Thomas Jefferson arranged to buy a large amount of land from France. This is known as the Louisiana Purchase. It amounted to over 500 million acres and included most of the land from the Mississippi River west to the Rocky Mountains, except what is now the State of Texas. The Louisiana Purchase cost the United States about $23 million.

Then in 1819 the land that is now Florida became part of the United States. Texas became part of the United States in 1845. A year later the United States signed a treaty with Great Britain which added the area that is now the States of Oregon, Washington, and Idaho. This treaty is known as the Oregon Compromise.

In 1848, just one year before the discovery of gold in California, the United States obtained from Mexico the lands that are now the States of California, Nevada, Utah and parts of Arizona, Wyoming, and Colorado. The Gadsden Purchase in 1853 added what is now southern Arizona.

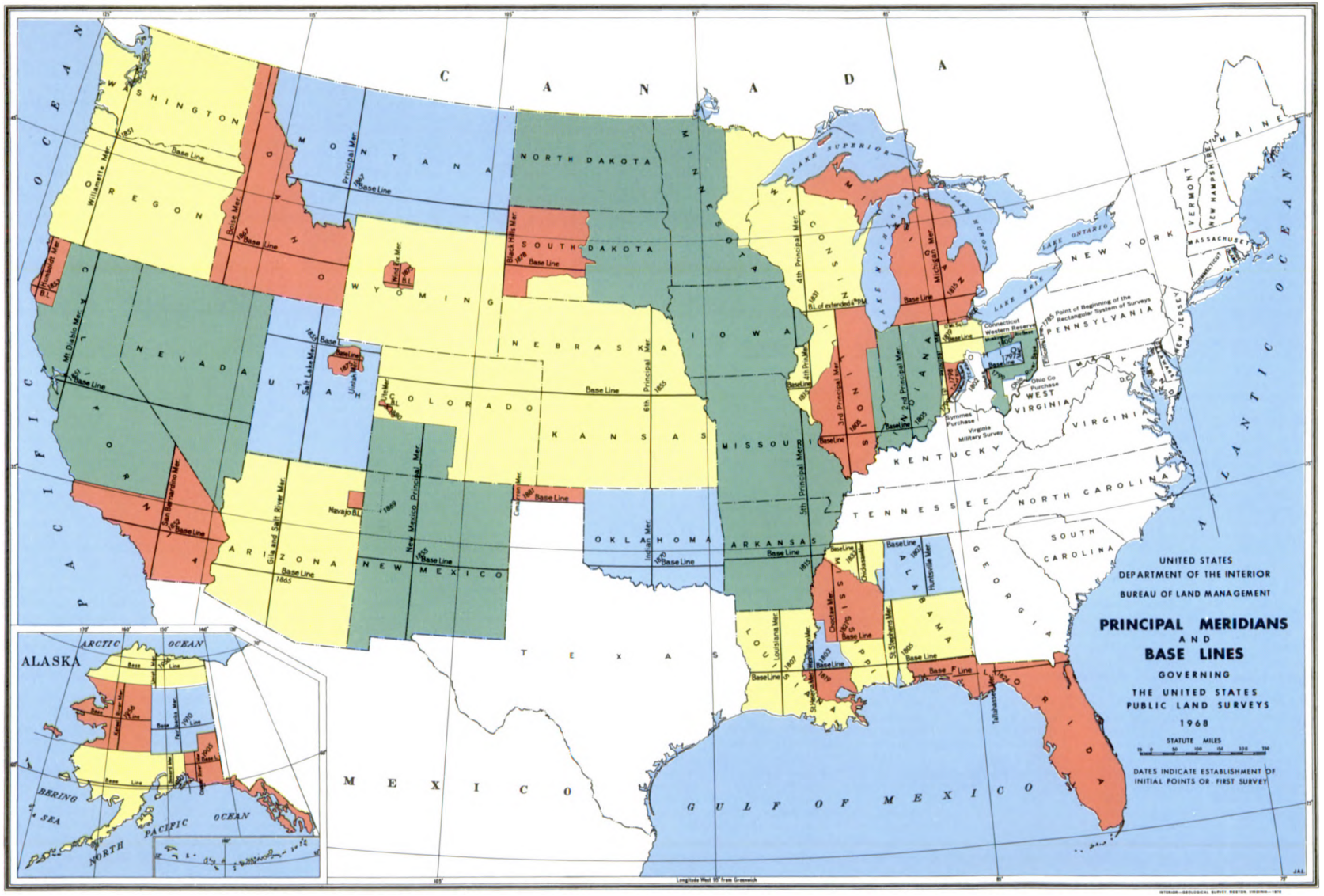
The last large addition to the land area of the United States came in 1867 when the United States purchased Alaska from Russia. The area of Alaska amounted to over 375 million acres (that is about one-fifth the area of the rest of the United States). It cost about $7 million.

With these additions, the public domain stretched from the west boundary of Pennsylvania to the Pacific Ocean, from the Canadian border to the Gulf of Mexico, and it included Florida and Alaska. Altogether it embraced over 1 billion 800 million acres.



(1) THE ORIGINAL THIRTEEN STATES
(2) 1790 NORTH CAROLINA CESSION
(3) 1781-1802 STATE CESSIONS
(4) 1803 LOUISIANA PURCHASE
(5) 1818 RED RIVER OF THE NORTH
(6) 1819 TREATY WITH SPAIN
(7) 1845 ANNEXED TEXAS
(8) 1846 OREGON COMPROMISE
(9) 1848 MEXICAN CESSION
(10) 1850 PURCHASED FROM TEXAS
(11) 1853 GADSDEN PURCHASE
(12) 1867 PURCHASED FROM RUSSIA
(13) 1898 ANNEXED HAWAII

ACQUISITION OF THE TERRITORY OF THE UNITED STATES



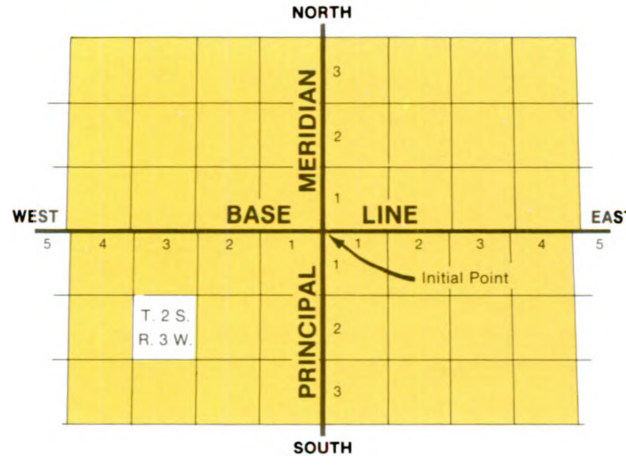
The Rectangular Survey System . . . .

Our present system of public land survey still retains the basic elements set forth in the Ordinance of 1785, but subsequent legislation and regulations have added refinements.

Under the cadastral system the public domain is plotted into a grid of squares, each approximately six miles to the side, called "townships."

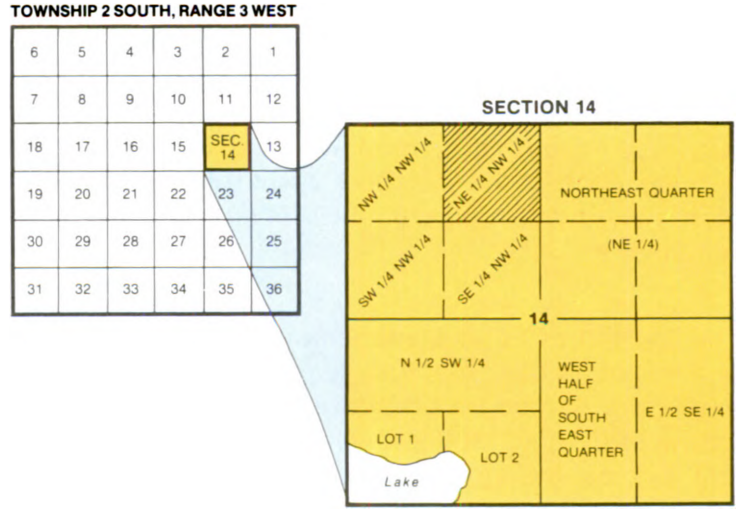
Before any measurement can be made, the surveyor must define an initial point for which he knows the exact latitude and longitude. From that initial point he runs two lines, one north-south, the other east-west. The north-south line becomes a principal meridian and is identified by a name — the Salt Lake Meridian, for example. The east-west line becomes the base line for that meridian (see map, page 8).

TOWNSHIP GRID



Working from a principal meridian and a base line the surveyor marks off the township lines into grids of 36 square miles.

Working along the principal meridian and the base line, the surveyor sets township corners at six-mile intervals, and then, by extension, the tract is marked off into a grid. Each of the six-mile squares is a township of 36 square miles, or approximately 23,040 acres. Any specific township can then be located according to its relationship to the appropriate principal meridian and the base line.



Townships were further divided into sections of one square mile (640 acres). Sections are then numbered from 1 to 36.

Because of the shape of the earth, principal meridians come closer together as they extend toward the North Pole. To adjust for this, correction lines are run every 24 miles.

The township is further divided into sections of one-mile squares containing 640 acres. Individual sections are identified by a numbering system that starts with section 1 in the northeast corner of the township and ends with section 36 in the southeast corner.

The section can be further sub-divided into quarter sections of 160 acres which became the basic unit under the Homestead Act of 1862. Quarter sections can be divided into half-quarter sections of 80 acres or into quarter-quarter sections of 40 acres. etc.

From the settler's point of view, the rectangular system forced him to take undesirable land along with that he deemed desirable. However, this disadvantage may have been more than offset since there was less chance of boundary disputes and fewer cases of expensive litigation than there would have been under a system of metes and bounds.

Under the rectangular survey system it is very easy to describe and locate any one parcel of land. There cannot be another parcel of land with the same identification. In order to avoid writing out a lengthy description a shorthand method of describing has been devised. For example, in the illustration on page 9, the example township is located two townships south of the base line and three ranges west of the principal meridian. In short from, the location of the township would be written "T. 2 S., R. 3 W." In formal land descriptions it is also necessary to include the name of the principal meridian.

The example section on page 9 would be described as "sec. 14, T. 2 S., R. 3 W." and the name of the principal meridian. Although the name of the state is not required, it is usually added for convenience. One of the advantages of this system of land description is that the method allows land to be described by very small legal subdivisions without an actual detailed field survey.

Quarter divisions of a section of land are known as "aliquot parts." An aliquot part is always described in relation to the four points of the compass. In the lower illustration on page 9 the hatched portion would be described as the "northeast quarter of the northwest quarter (NE¼NW¼) sec. 14, T.2 S., R.3 W." and the name of the principal meridian.

The Bureau of Land Management has sometimes found it necessary to approve uses of land tracts before actual survey has been performed. These administrative requirements are handled by a system of "protracted surveys" — lines drawn on maps that follow the public land survey system, even though the boundaries have not yet been laid out on the ground. Protractions help in locating oil and gas leases and they provide a means for recording actions dealing with public lands.

Protractions will not take the place of the final official survey but they do provide a present basis for many types of land management.

The Federal Cadastral Surveyor . . . .

Surveyors are usually within one of three groups — geodetic surveyors measure the shape and size of the earth; topographic surveyors locate and map the earth's features including its contours, water bodies, roads and buildings; cadastral surveyors lay out and mark property boundaries according to legal requirements and doctrines.

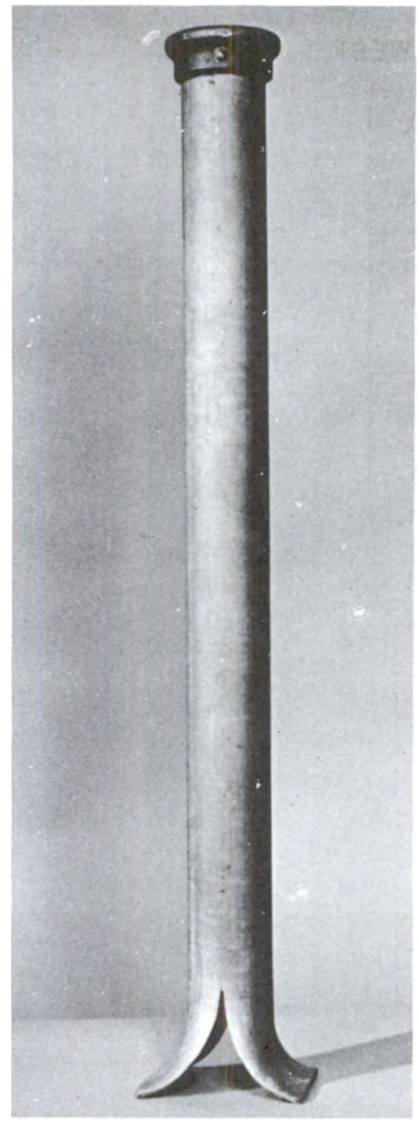
Today, in the BLM, there are about 200 permanent cadastral surveyors who are charged with surveying and resurveying 473 million acres of land — more than is held by all other Federal agencies combined.

To augment this corps of professionals, BLM employs seasonal survey aids who operate surveying instruments, cut brush, climb hills, maintain equipment, and set permanent monuments.

There are also professional cadastral surveyors employed by several other government agencies for specialized purposes such as land line location and boundary management in the U.S. Forest Service.

Travel and long stays away from home offices are common place for BLM field surveyors. A good degree of self-reliance is a desirable attribute of surveyor-party chiefs since independent decisions on both technical and crew management matters are frequently needed. Personnel management and logistical abilities are sometimes critical (such as for a six months Alaskan field camp operation).

BLM surveyors go to and from work sites on just about anything that moves, including by foot, horseback, four-wheel drive vehicles, helicopter, and boat. Survey work is carried on anywhere in the United States — from the Arizona deserts to the Alaskan tundra, along the edge of a large water body, or in a dense forest on the sides of a western mountain.



CORNER MONUMENT. The exact location of the corner is stamped on top. The bottom is spread out to prevent pulling the post from the ground.

Congress authorized the use of metal monuments in 1908. Stone monuments were principally used before then.

Cadastral Surveys fall into two main categories, original surveys and resurveys. Since the majority of the land in the lower

48 states has already been originally surveyed, most original survey work is actively carried on in Alaska, quite often in remote, roadless areas.

Resurveys have always been necessary in marking the public lands in order to restore obliterated or lost original survey lines. Statutory authority for resurveys was given by Congress in 1909. Resurveys now compose the most challenging and complex projects for the BLM surveyor.

However, it is legally stipulated that no resurvey can impair the bona fide land rights of affected claimants. Corners established in original cadastral surveys are forever fixed in position even though they may not fall precisely at a stated bearing and distance from a previous point. Today's Cadastral Surveyor must weigh many kinds of evidence in order to ensure the protection of private rights.

In recent years, modern technology has replaced the traditional "chain" measuring tape with electronic instruments. Microwave, light wave, laser beam, photogrammetry, and gyroscopic orientations are among the scientific mediums being fused into the Cadastral Surveyor's array of working tools.

New, highly sophisticated surveying techniques range from "Total Station" concepts where all azimuthal and distance data are automatically recorded for later computer processing, to inertial guidance systems which give continuously updated coordinates of airborne positions. Alaskan surveyors use this "black box" system to rapidly meet the survey demand of millions of acres of land scheduled for transfer under the Native Claims and Alaska Statehood Acts.

The physical challenge to the Cadastral Surveyor of laying boundaries across the terrain remains. The mental challenges are increasing. The future survey of our public lands will call for technically adept surveyors who are willing to integrate the wisdom and experience of their predecessors with the expanding knowledges and uses of both the scientific and managerial regimes.

SHORT LIST OF SURVEYING TERMS

Bearing Tree — A marked tree used as a corner accessory; its distance and direction from the corner being recorded. Bearing trees are identified by prescribed marks cut into their trunks; the species and sizes of the trees are also recorded.

Corner — A point on the earth, determined by the surveying process, which defines an extremity on a boundary.

Field Notes — The official written record of the survey, certified by the field surveyor and approved by proper authority. Originally, Field Notes were prepared by hand, but they are now typewritten.

Meander Line — a traverse of the margin of a permanent natural body of water.

Monument — The physical object which marks the location of a corner point.

Original Survey — a cadastral survey which creates land boundaries and marks them for the first time.

Plat — As used technically by BLM, a graphic representation drawn to scale depicting the actual survey as described in the official field notes.

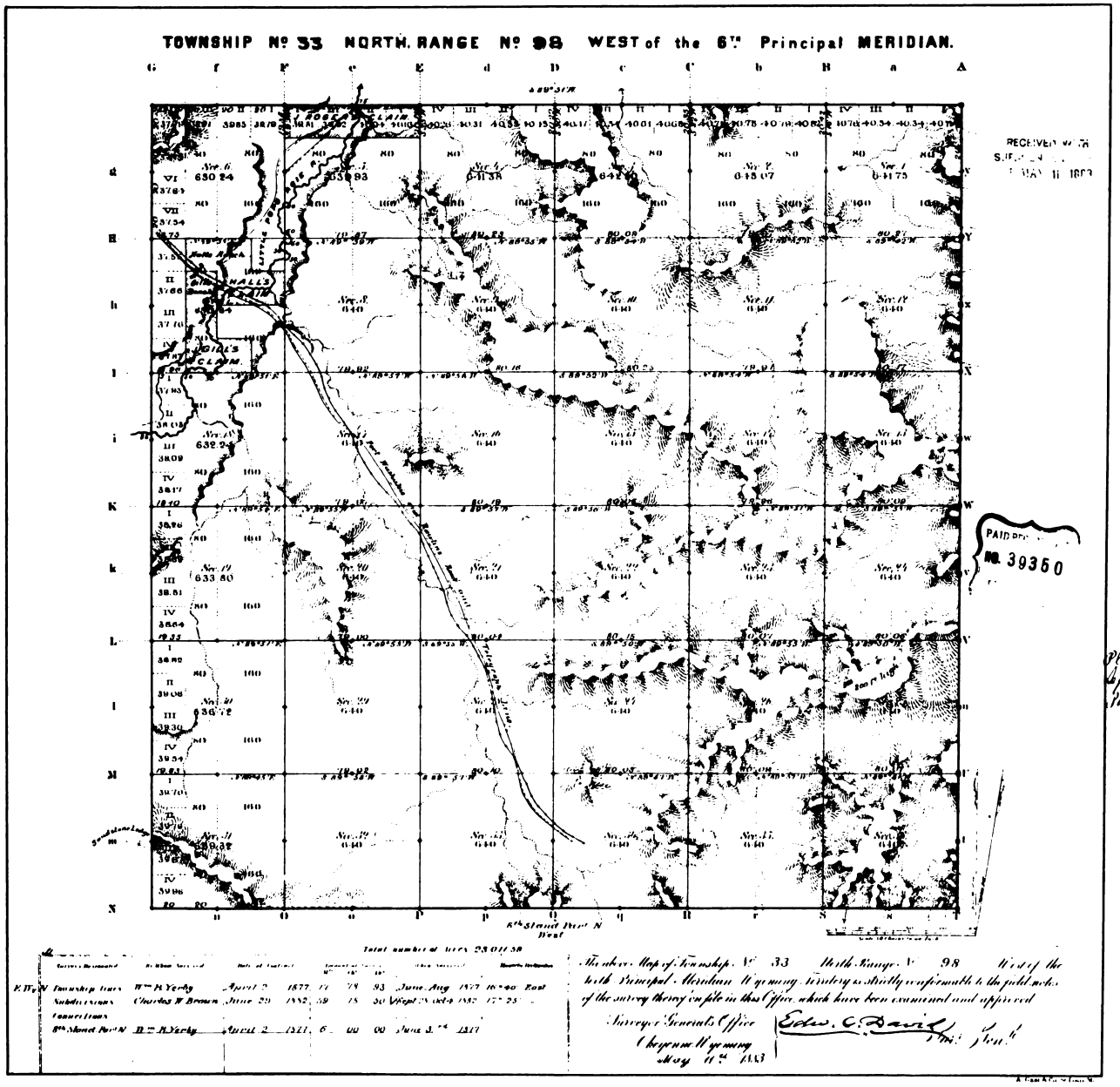
Resurvey — Cadastral Survey to identify and remark the boundaries of lands which were established by an earlier survey.

Traverse — A sequence of lengths and directions of lines connecting a series of stations.

Witness Corner — A monumented point usually on the true line of the survey near a corner point which cannot be physically occupied or which falls at a place subject to destruction by the elements. The witness corner is then a reference to the true corner point.

17.00	Foot of ridge brs. N. W. and S. E.
40.00	Set a granite stone 13 x 9 x 7 ins. 10 ins. deep for 1/4 sec. cor. marked 1/4 on W. face and raised a mound of stone. Site impracticable
80.00	Set a granite stone 15 x 10 x 6 ins. 10 ins. deep for cor. to secs. 7. 8. 17 - 18. marked with 4 notches on S. and 3 on E. edges and raised a mound of stone. Site impracticable.
	Land rolling.
	Soil. 2nd. rate.
	Veg. grass and sage.
	October 3 rd. 1882.
	East on a random line bet. Secs. 8 and 17.
	Va. 17° 25' East.
12.00	Fort Washakie and Rawlins. wagon road brs. N. 30° W. and S. 30° E.
16.00	Fort Washakie and Rawlins. Telegraph line brs. N. 30° W. and S. 30° E.
22.00	Drain 20 lks. wide descends N. 15° W.
40.00	Set a stone for temp. 1/4 sec. cor.
79.92	Intersect N. and S. line 8 lks. N. of cor. to secs. 8. 9. 16 - 17. Thence I run
	N. 89° 57' W. on a true line bet. Secs. 8 and 17. with same variation.
39.96	Set a granite boulder 14 x 9 x 6 ins. 10 ins. deep for 1/4 sec. cor. marked 1/4 on N. face, and raised a mound of stone. Site impracticable.
79.92	The cor. to secs. 7. 8. 17 - 18.
	Land rolling.
	Soil 2 nd. rate.
	Veg. grass and sage.
	West on a random line line bet. Secs. 7 and 18.
	Va. 17° 25' E ast.
15.00	Enter river bottom brs. N. E. and S. W.
20.00	To the S. E. cor. of Wm. Gillis claim.
40.00	Set a stone for temp. 1/4 sec. cor.
44.00	Little Popo Agie river 50 lks. wide runs N. E.

Handwritten field notes of an original cadastral survey in Wyoming (1882).



Original survey plat of a Wyoming Township.

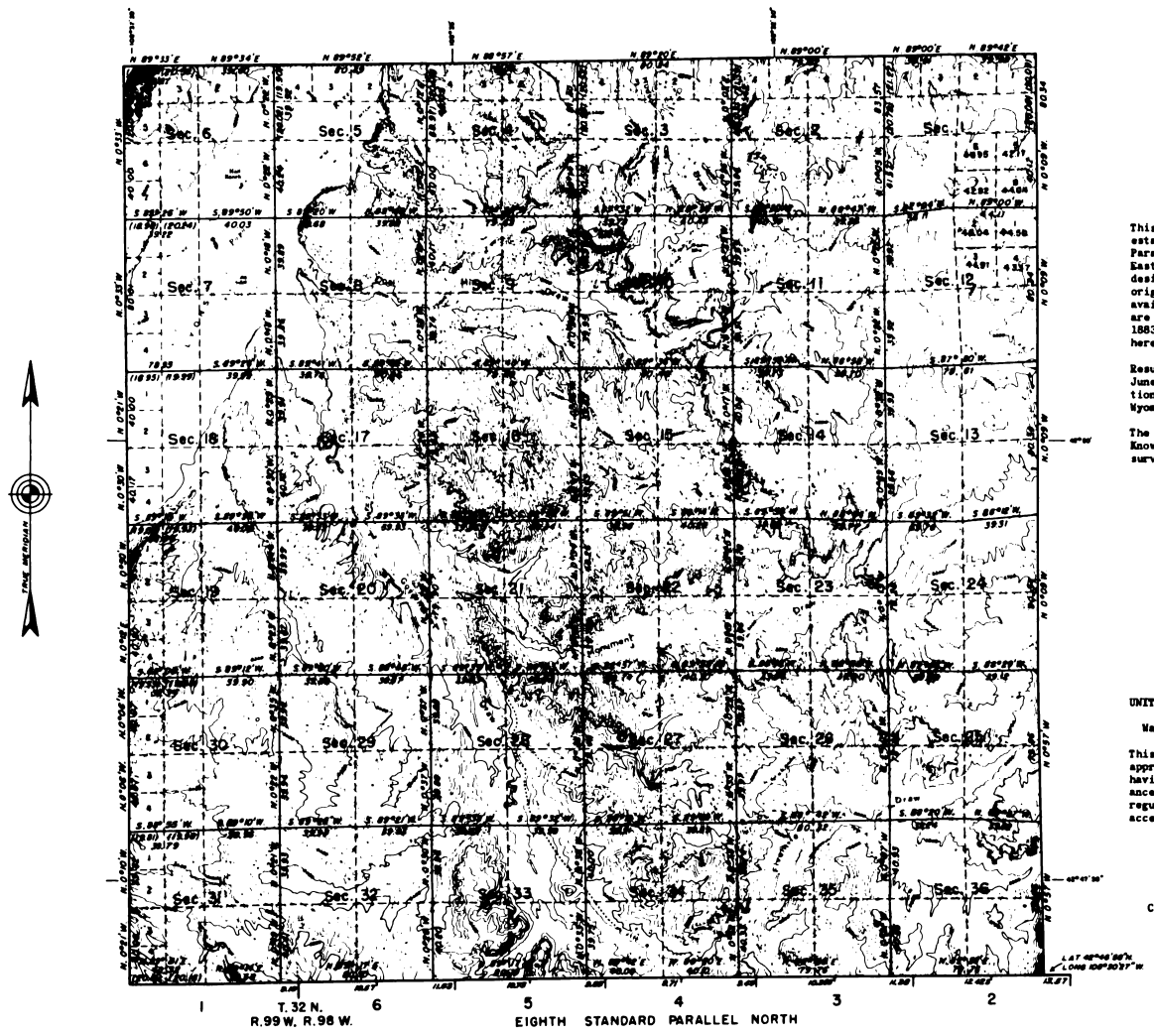
Dependent Resurvey of the subdivisional lines of T. 33 N., R. 98 W.

Chains	
	From the corner of secs. 8, 9, 16 and 17.
	S.89° 58'W., between secs. 8 and 17.
	Over rolling land.
19.60	Draw, course NNW.
26.75	Draw, course NNW.
31.40	Draw, course NNW.
40.06	The ¼ sec. corner of secs. 8 and 17, monumented with a granite stone 16 X 10 X 7 ins. firmly set 8 ins. in the ground and chiseled ¼ on the N, face.
	At the corner point
	Set an iron post 28 ins. long, 2½ ins. in diam., 25 ins. in the ground with brass cap mkd.
	S 8 ¼ S 17 1952
	Bury the original stone and set a 2 X 4 in. white guard post along side of the corner monument.
	S.89° 41'W., beginning new measurment.
	Over rolling land.
00.30	Trail road, bears N. and S.
1.25	Fence line, bears N. and S.
2.55	Irrigation ditch, flows N. Thence across level alfalfa field.
11.00	Leave alfalfa field, continue across level bottom land.
19.80	Government Draw, course NNW.

Resurvey field notes of the original Wyoming survey on Page 14 (1952).

TOWNSHIP 33 NORTH, RANGE 98 WEST OF THE SIXTH PRINCIPAL MERIDIAN, WYOMING.

DEPENDENT RESURVEY



This plat represents a retracement and re-establishment of the Eighth Standard Parallel North through Range 98 West, the East boundary, and the subdivisional lines designed to restore the corners in their original locations according to the best available evidence. The lottings and areas are as shown on the plat approved May 11, 1883, except as new lottings are shown hereon.

Resurvey executed by Allan R. Arnold June 4 to 9, 1952, under special instructions dated May 5, 1945 for Group 207, Wyoming.

The West boundary resurveyed by John S. Knowles in 1947; the North boundary re-surveyed by R. C. MacDonald in 1952.

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
Washington, D.C. December 13, 1955

This plat is strictly conformable to the approved field notes, and the survey, having been correctly executed in accordance with the requirements of law and the regulations of this Bureau, is hereby accepted.

For the Director

Earl D. Harrington

Cadastral Engineering Staff Officer

CHAINS

CONTOUR INTERVAL 20 FEET

Area resurveyed: 23,040.39 acres

Topographic mapping and reproduction by the U. S. Geological Survey from portions of Lander and Lander SE quadrangles.

Resurvey plat of the Township and field notes on pages 14 and 15.

The chain is the unit of linear measurement for the survey of the public lands as prescribed by law. All returns of measurement in the rectangular system are made in the true horizontal distance in links, chains, and miles. The only exceptions to this rule are special requirements for measurement in feet in mineral surveys and townsite surveys.

LINEAR MEASUREMENT

1 Chain = 100 links or 66 feet
1 Mile = 80 Chains or 5,280 feet

AREA MEASUREMENT

1 Acre = 10 square chains or 43,560 square feet
1 Square Mile = 640 acres